TECHNICAL REPORT NO. 68-20

LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT

Quarterly Report No. 2, Project VT/6706

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GEOTECH

A TELEDYNE COMPANY

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TECHNICAL REPORT NO. 68-20

LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT
Quarterly Report No. 7, Project VT/6706

by

B. M. Kirkpatrick

Sponsored by

Advanced Research Projects Agency
Nuclear Test Detection Office
ARPA Order No. 624

GEOTECH
A TELEDYNE COMPANY
3401 Shiloh Road
Garland, Texas

4 June 1968

IDENTIFICATION

AFTAC Project No:	VELA T/6706
Project Title:	Long-Period Seismograph Development
ARPA Order No:	624
ARPA Program Code No:	6F10
Name of Contractor:	Geotech, A Teledyne Company Garland, Texas
Date of Contract:	15 June 1966
Amount of Contract:	$246,713
Contract Number:	AF 33(657)-16406
Program Manager:	David B. Andrew BR 1-2561, Area Code 214

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS, Continued

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TABLES

ABSTRACT

Field testing of the long-period triaxial seismometer has continued at the Uinta Basin Seismological Observatory (UBSO). The results of tests involving artificially induced tilt and the response of the system to wind and barometric pressure change are presented.

LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT

1. INTRODUCTION

This report describes the work performed by Geotech, A Teledyne Company, in accordance with the Statement of Work to be Done in AFTAC Project Authorization No. VELA T/6706, dated 11 March 1966. The project is under the technical direction of the Air Force Technical Applications Center (AFTAC) and the overall direction of the Advanced Research Projects Agency (ARPA).

This report discusses the progress made on the development of a long-period (LP) triaxial seismometer. The period covered by this report extends from 1 January 1968 to 31 March 1968 and deals mainly with the field operation of the long-period triaxial seismograph at the shallow-hole test facility located at the Uinta Basin Seismological Observatory (UBSO) and the redesign of an improved triax module at the Garland plant.

2. PRELIMINARY TESTING OF THE LONG-PERIOD TRIAXIAL SEISMOMETER, TASK 1c

The seismograph, utilizing the Model 26310 long-period triaxial seismometer, has been operated at three specific depths in the shallow hole during this reporting period. The relative operational improvement as the seismometer was positioned lower in the hole is illustrated in figure 1. The three separate samples reflect operation of seismometer module No. 1 at depths of 55, 115, and 175 feet. The general background level of the bottom trace illustrated agrees quite favorably with the advanced long-period system (ALPS) operating at UBSO.

Routine operation of the seismograph by UBSO personnel began on 24 January 1968. Analog transformation of the triaxial data to a horizontal and vertical presentation is being performed at the site in an effort to confirm proper operation of the triax seismograph. This is illustrated in figure 2 which shows the operational agreement between the coordinate transformed triaxial (triax sum, ZCT, NCT, and ECT) and the advanced long-period seismograph (ZLP_2, NLP_2, and ELP_2) systems. The figure is presented at X5 instead of X10 enlargement of 16 mm film in order to show more operation of the systems. For this reason, magnifications in the figures are about 25K at 25 sec. The figure shows the response of the systems to a teleseismic event with the triaxial seismometer positioned at the 175 ft level in the 200 ft deep hole. The agreement between the systems is obvious when the triax sum and the transformed vertical trace (ZCT) are compared to the advanced vertical (ZLP_2), the transformed north (NCT) is compared to the advanced north (NLP_2), and the transformed east (ECT) is compared to the advanced east (ELP_2).

System amplitude and phase responses were taken and minor adjustments were necessary in order to provide matched responses. Figures 3 and 4 show the

amplitude and phase response curves for triax seismograph No. 1. The other two triax system responses were very closely matched to those of seismograph No. 1 and therefore are not included. Both the triax system and the ALPS normalized amplitude and phase values taken are listed in tables 1 and 2.

Operation of the triaxial seismograph system is being maintained by UBSO station personnel. Work under Task 1c is complete and further reporting on this task is not anticipated.

3. FIELD MEASUREMENTS WITH THE LONG-PERIOD TRIAXIAL BOREHOLE SEISMOMETER, TASK 1d

3.1 RESPONSE TO ARTIFICIALLY INDUCED SURFACE TILT

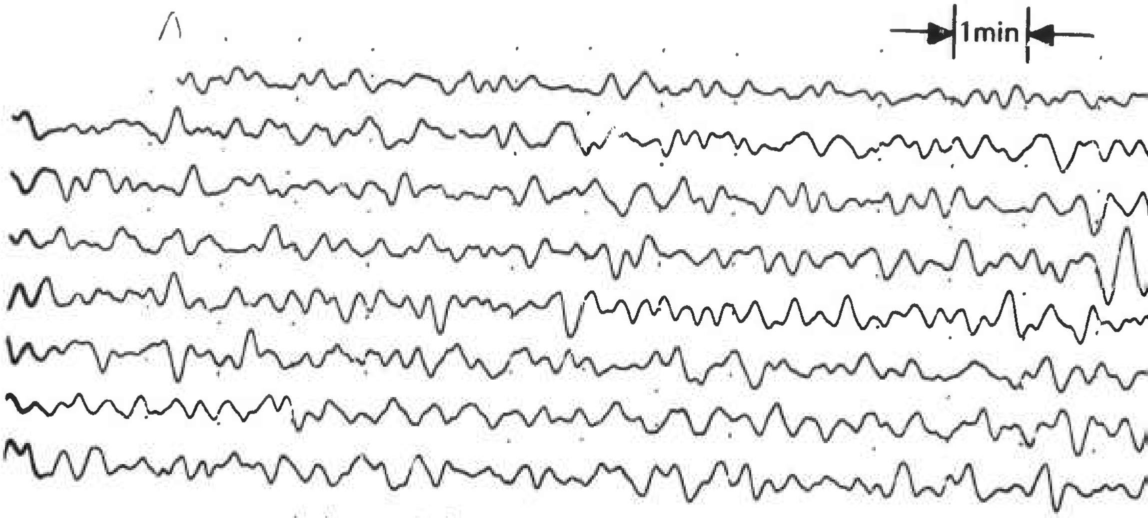
Figure 5 shows the results of a "truck test" to determine the relative responses f the LP triaxial seismometer and the ALPS to surface tilt. The test consisted of driving a 3/4-ton (5040 pounds) dual-wheel truck successively past, and within 10 feet of, the advanced LP vault and the LP triaxial shallow-hole installation. The following table gives the times, the truck speed, and the sequence of the runs.

Run #	Time		Truck speed (mph)	Direction
	Begin	End		
1	0050	0051	0.5	South to North
2	0055	0056	2.5	North to South
3	0058	0059	10.0	South to North
4	0100	0101	14.0	North to South

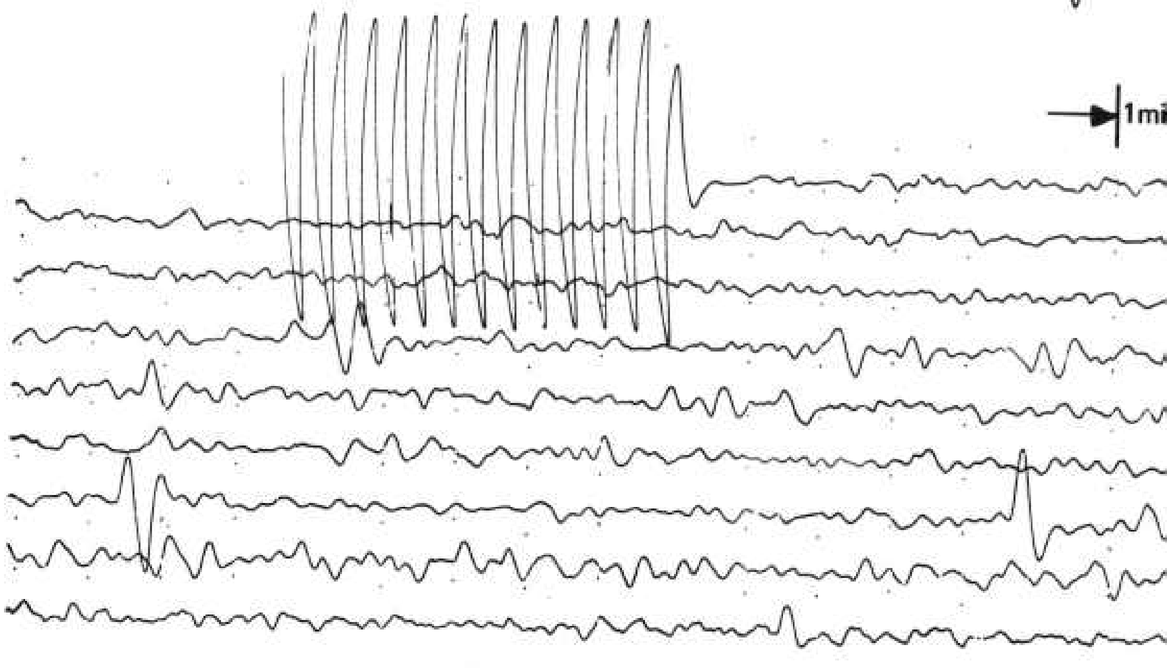
Since the advanced LP vault is located generally south of the triaxial installation, the south-to-north runs are detected first by the ALPS (ZLP_2, NLP_2, and ELP_2) and next by the triaxial (T_1LP, T_2LP, and T_3LP). In the north-to-south runs, the order of detection is reversed.

A direct comparison between the relative responses of the two systems to surface tilt can be made by studying the advanced LP traces in figure 5 and comparing them to their coordinate transformed triaxial counterparts. Thus, the advanced vertical seismograph ZLP_2 can be compared to ZCT; the advanced north NLP_2 can be compared to NCT; and the advanced east ELP_2 can be compared to ECT. It is seen from the figure that although the triaxial showed some response to the truck induced surface tilt, the amplitude of the response is substantially less than that of the advanced LP instruments. The tilt sensitive horizontal instruments NLP_2 and ELP_2 showed the greatest response as might be expected.

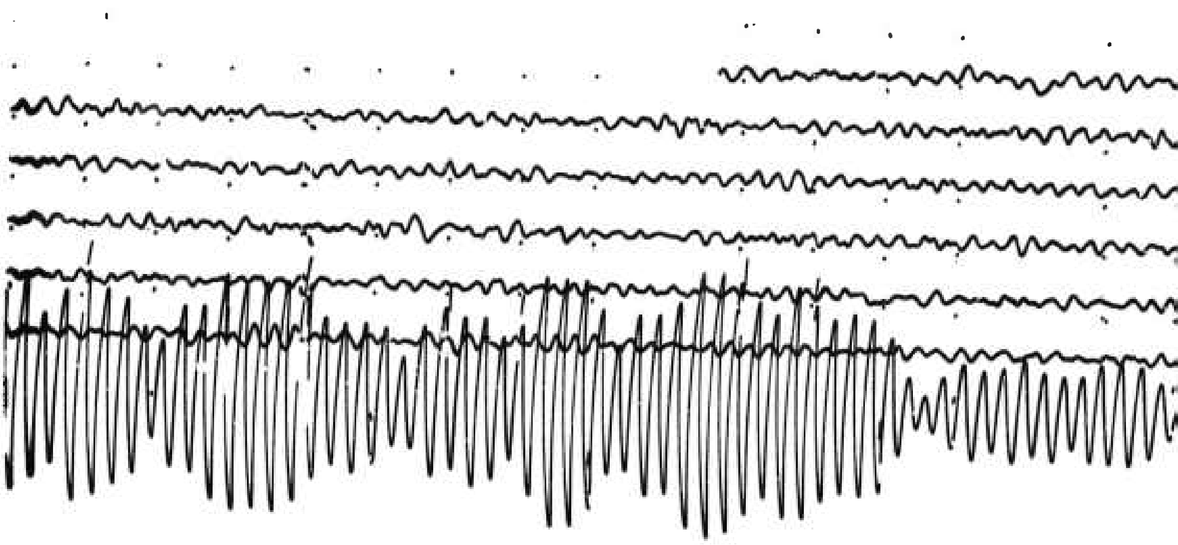
Triax Seismograph No. 1
Direction - North
Mag ≈ 12K @ 25 sec
Depth 55 ft



Triax Seismograph No. 1
Direction - North
Mag ≈ 12K @ 25 sec
Depth 115 ft



Triax Seismograph No. 1
Direction - North
Mag ≈ 12K @ 25 sec
Depth 175 ft



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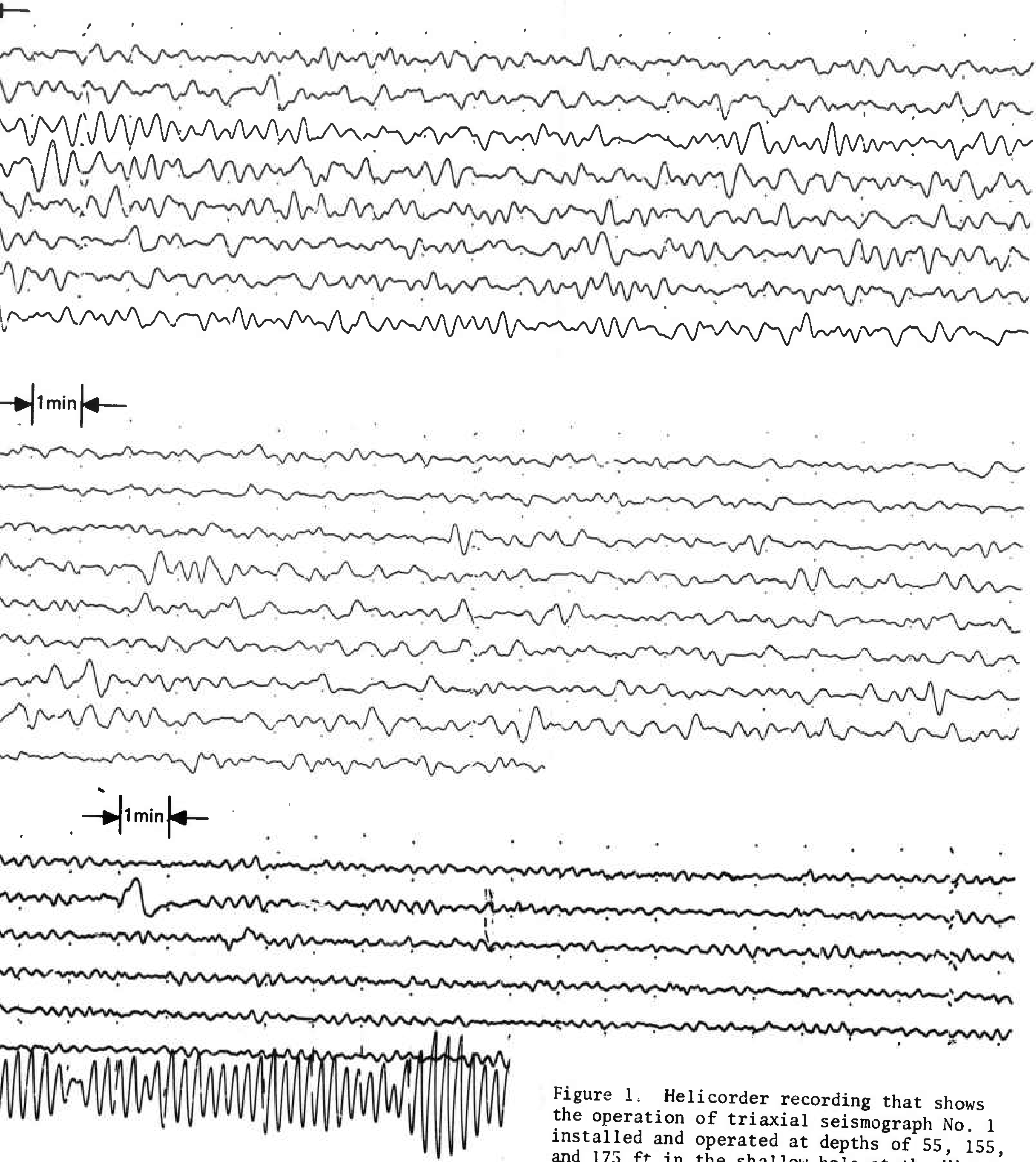

Figure 1. Helicorder recording that shows the operation of triaxial seismograph No. 1 installed and operated at depths of 55, 155, and 175 ft in the shallow-hole at the Uinta Basin Seismological Observatory

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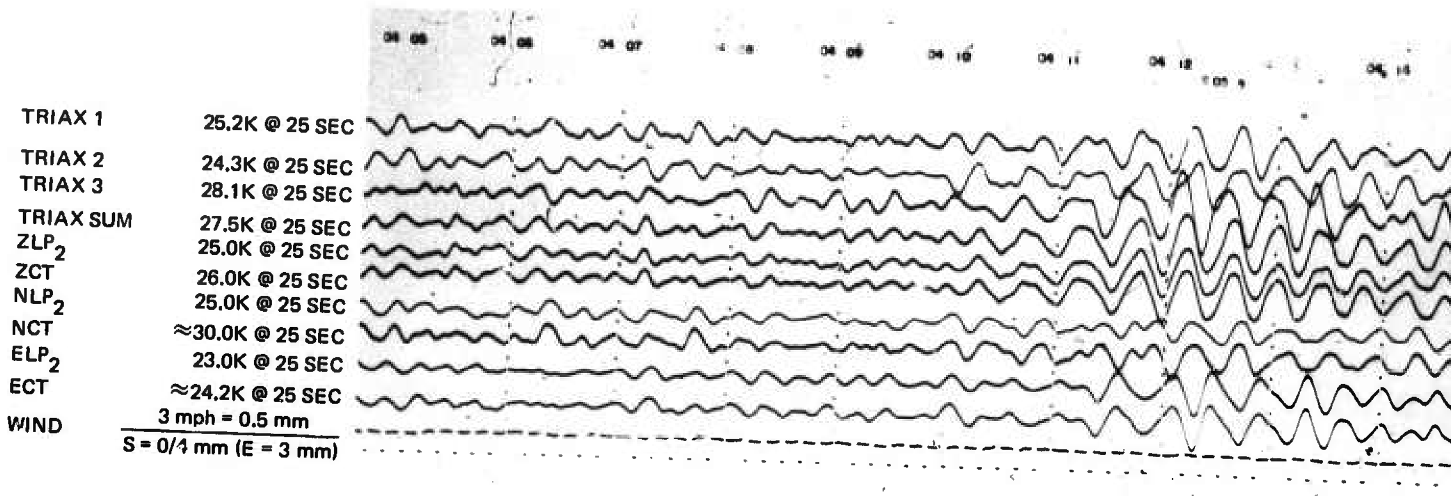

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RUN 059
28 FEBRUARY 1968

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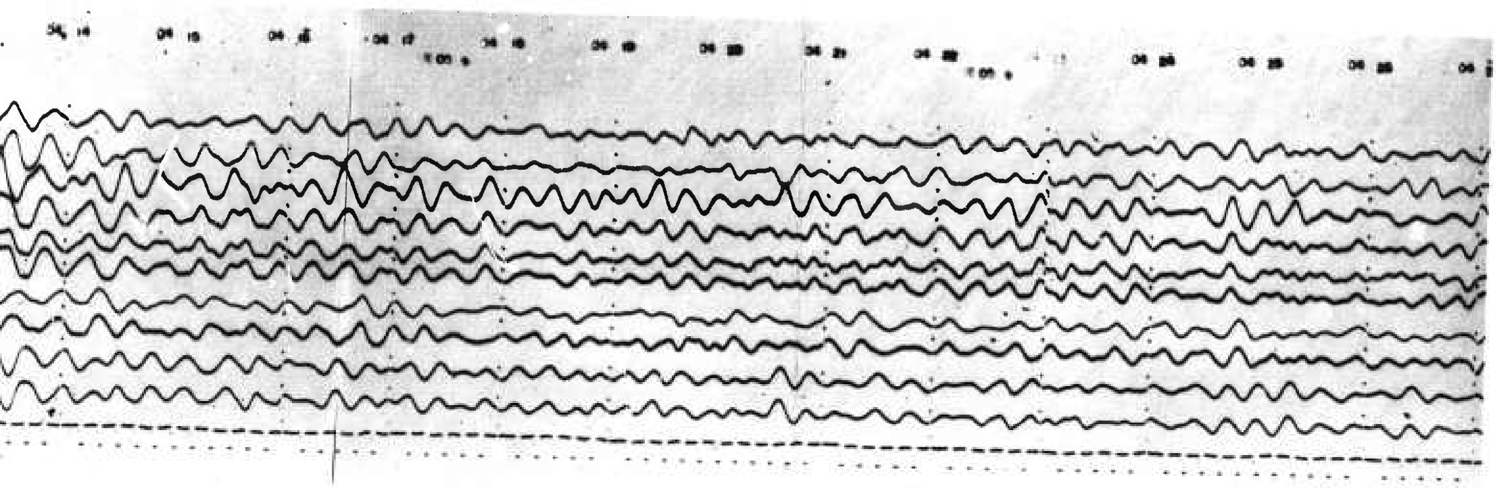

Figure 2. Seismogram showing a portion of a teleseismic event demonstrating the operational agreement between the transformed triaxial traces (triax sum, ZCT, NCT, ECT) and the advanced long-period traces (ZLP_2, NLP_2, ELP_2)(X5 enlargement of 16 millimeter film)

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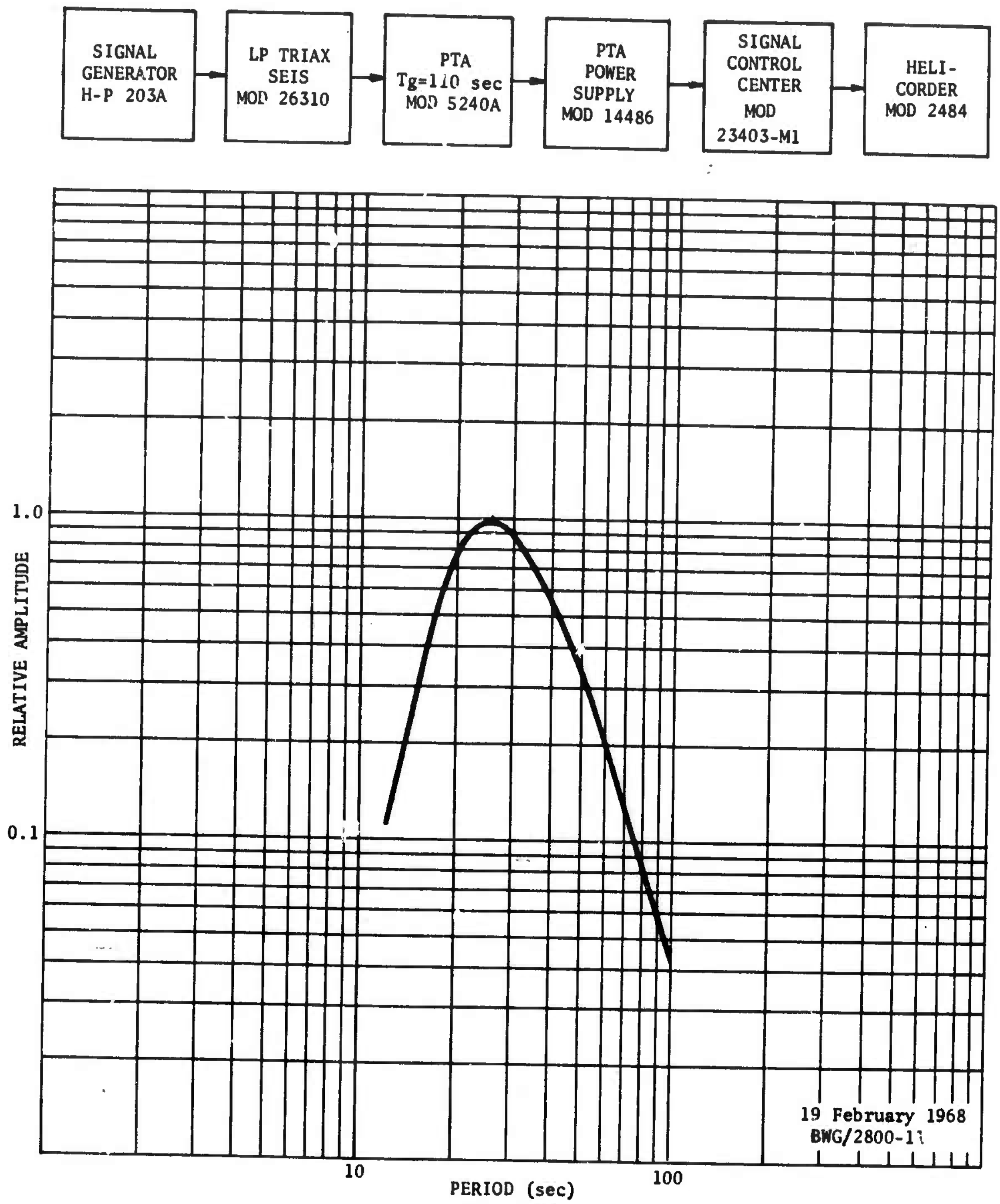

Figure 3. Empirical amplitude response curve for the long-period triaxial borehole seismograph No. 1 operating in the 200 foot deep test borehole at Uinta Basin Seismological Observatory (UBSO)

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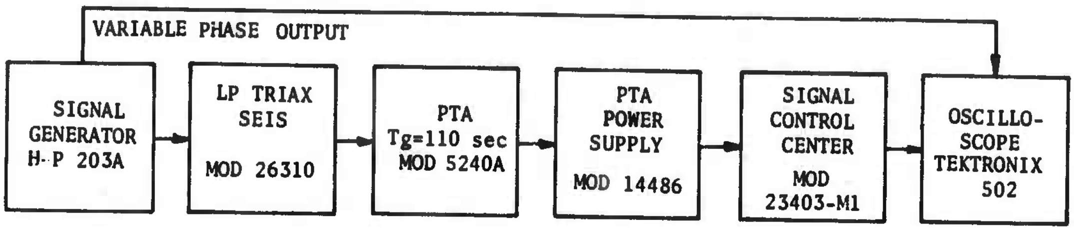

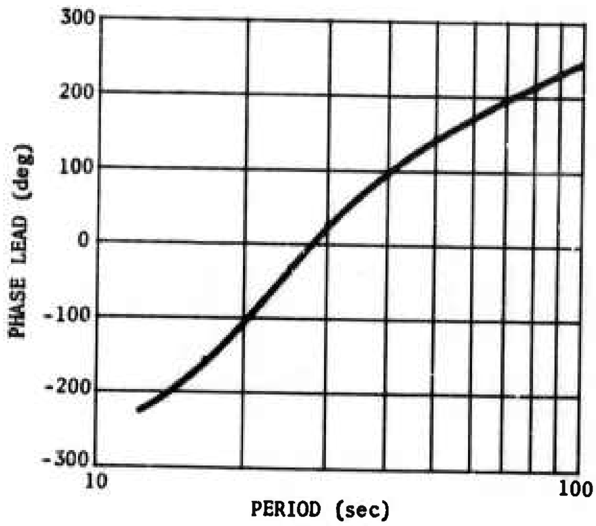

28 February 1968
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Figure 4. Empirical phase response curve for the long-period triaxial borehole seismograph No. 1 operating in the 200 foot deep test borehole at Uinta Basin Seismological Observatory (UBSO)

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Table 1. Empirical amplitude response data for the long-period triaxial and advanced long-period seismographs at the Uinta Basin Seismological Observatory obtained on 19 February 1968 and 1 March 1968 respectively

Period (sec)	T_1LP	T_2LP	T_3LP	ZLP_2	NLP_2	ELP_2
			Relative amplitude			
100	0.043	0.049	0.042	0.065	0.0568	0.0554
80	0.090	0.090	0.087	0.149	0.124	0.110
60	0.206	0.225	0.202	0.310	0.253	0.238
50	0.336	0.364	0.336	0.465	0.364	0.353
40	0.562	0.601	0.555	0.710	0.568	0.568
30	0.922	0.961	0.942	0.975	0.927	0.865
25	1.0	1.0	1.0	1.0	1.0	1.0
20	0.721	0.748	0.722	0.755	0.817	0.853
16.7	0.432	0.457	0.432			
15				0.352	0.379	0.379
12.5	0.108	0.108	0.108			
10				0.0745	0.071	0.088

Table 2. Empirical phase response data for the long-period triaxial and advanced long-period seismographs at the Uinta Basin Seismological Observatory obtained on 28 February 1968

Period (sec)	T_1LP $\phi°$	T_2LP $\phi°$	T_3LP $\phi°$	ZLP_2 $\phi°$	NLP_2 $\phi°$	ELP_2 $\phi°$
12.5	-192	-210	-210	-198	-240	-237
16.7	-161	-161	-154	-141	-172	-167
20	-110	-108	-103	- 93	-112	-106
25	- 38	- 37	- 27	- 31	- 33	- 29
30	22	18	31	19	35	30
40	97	95	105	91	96	103
50	143	139	147	137	138	146
60	173	171	179	166	172	178
80	209	209	215	211	212	213
100	243	245	249	251	246	248

3.2 RESPONSE TO WIND AND BAROMETRIC PRESSURE CHANGE

Figures 6, 7, and 8 are seismograms selected to show the relative response of the long-period triaxial and the ALPS systems to barometric pressure change accompanied by various wind conditions. Figure 6 shows the response of the two systems when subjected to moderate barometric pressure change and wind under 10 mph. An examination of the advanced long-period traces (ZLP_2, NLP_2, ELP_2) shows that the tilt sensitive horizontal seismometers (NLP_2 and ELP_2) and particularly the ELP_2, responded to the pressure pulse at 0638-0639Z. The correlative coordinate transformed triaxial traces (NCT, ECT) were affected to a lesser degree. The succeeding pressure changes, illustrated on the remainder of the seismogram, were not sufficiently great to cause an obvious displacement of the traces.

Figure 7 shows the response of the two systems when subjected to a larger pressure change and slightly higher wind velocity than that shown in figure 6. The pressure waves at 2036-2037Z and 2042-2043Z affected the triaxial traces significantly less than the advanced long-period traces.

Figure 8 shows the responses of the systems to high, gusting winds of from 35 to 40 mph. These winds, along with moderate barometric pressure changes, contributed to noisier background of this seismogram compared to that of figures 6 and 7. There appears to be a more general correlation of waveform between the pressure trace and the seismometer traces than can be explained on the basis of amplitude. This may be due to the higher frequency of the pressure wave compared to that shown in figures 6 and 7.

3.3 MULTIPLE COHERENCE AND SPECTRAL PLOTS

An attempt was made during this reporting period to obtain multiple coherence and spectral plots from the records of the long-period triaxial and the advanced long-period seismograph systems. Difficulty with the available digitizing equipment resulted in nonusable data. The digitizing run will be repeated in the near future using new equipment. This is expected to result in usable data allowing the coherence and spectral plots to be presented in a future report. This task will be considered complete when these plots have been published.

4. EVALUATION AND MODIFICATION OF THE LONG-PERIOD TRIAXIAL BOREHOLE SEISMOMETER, TASK 1e

The work on Task 1e began during this report period. This task consists in part of a cost evaluation and redesign of the seismometer module. The cost evaluation is expected to be completed by the middle of May, and construction of a redesigned module to be completed by the middle of June.

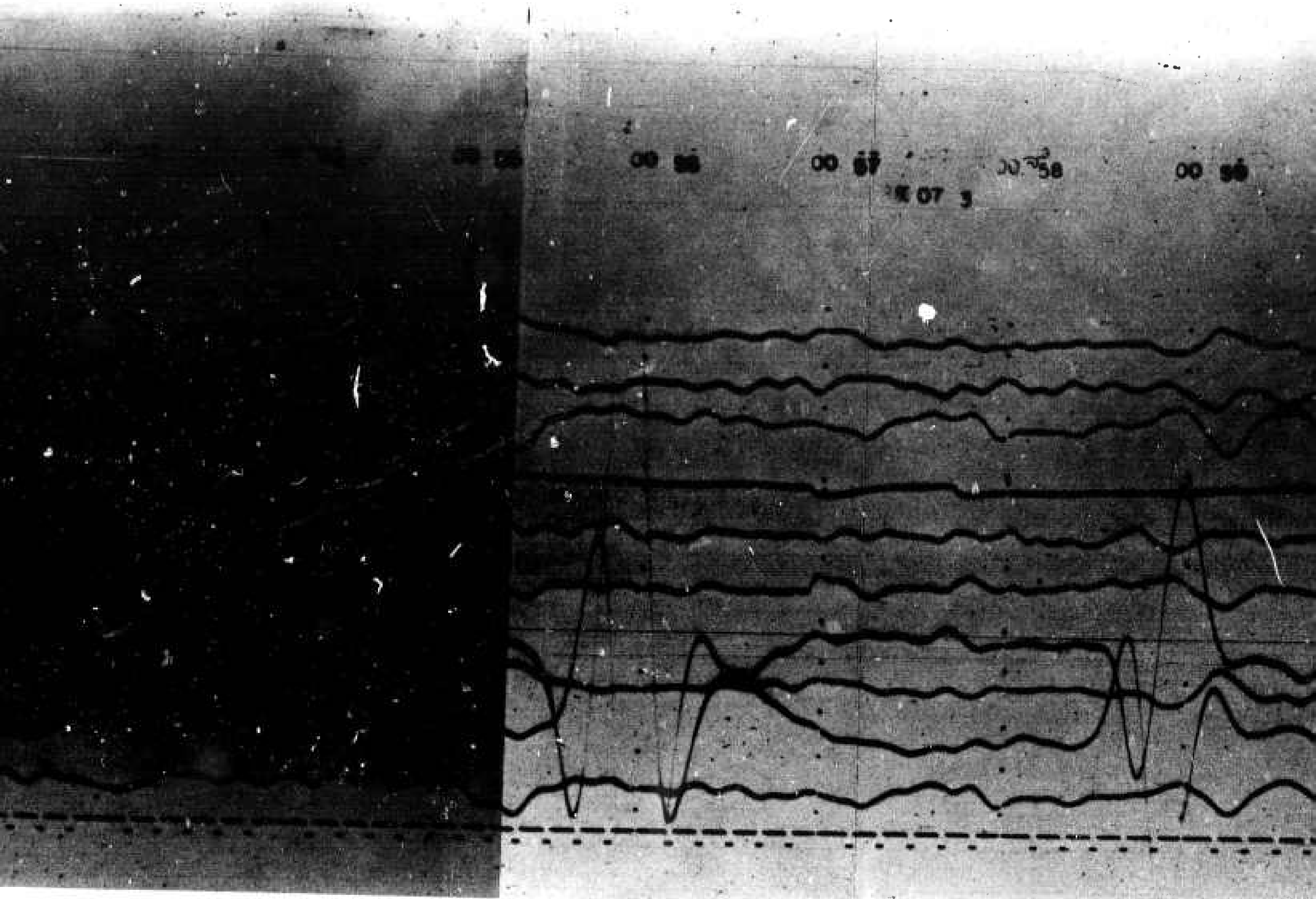
There are several areas where simplification and thus cost reduction of the seismometer module design has been possible. Among these are:

a. Period adjust mechanism;

UBSO
13 Mar 68
073-68

T_1LP	46.5K @ 25 sec
T_2LP	54.3K @ 25 sec
T_3LP	45.1K @ 25 sec
ML_2	1.19 μb/mm
ZLP_2	68K @ 25 sec
ZCT	48K @ 25 sec
NLP_2	48K @ 25 sec
NCT	$\approx$ 42K @ 25 sec
ELP_2	52K @ 25 sec
ECT	$\approx$ 55K @ 25 sec
WI	$\frac{3 \text{ mph} = 1 \text{ mm}}{S = 0\&8, E = 6\text{mm}}$

A



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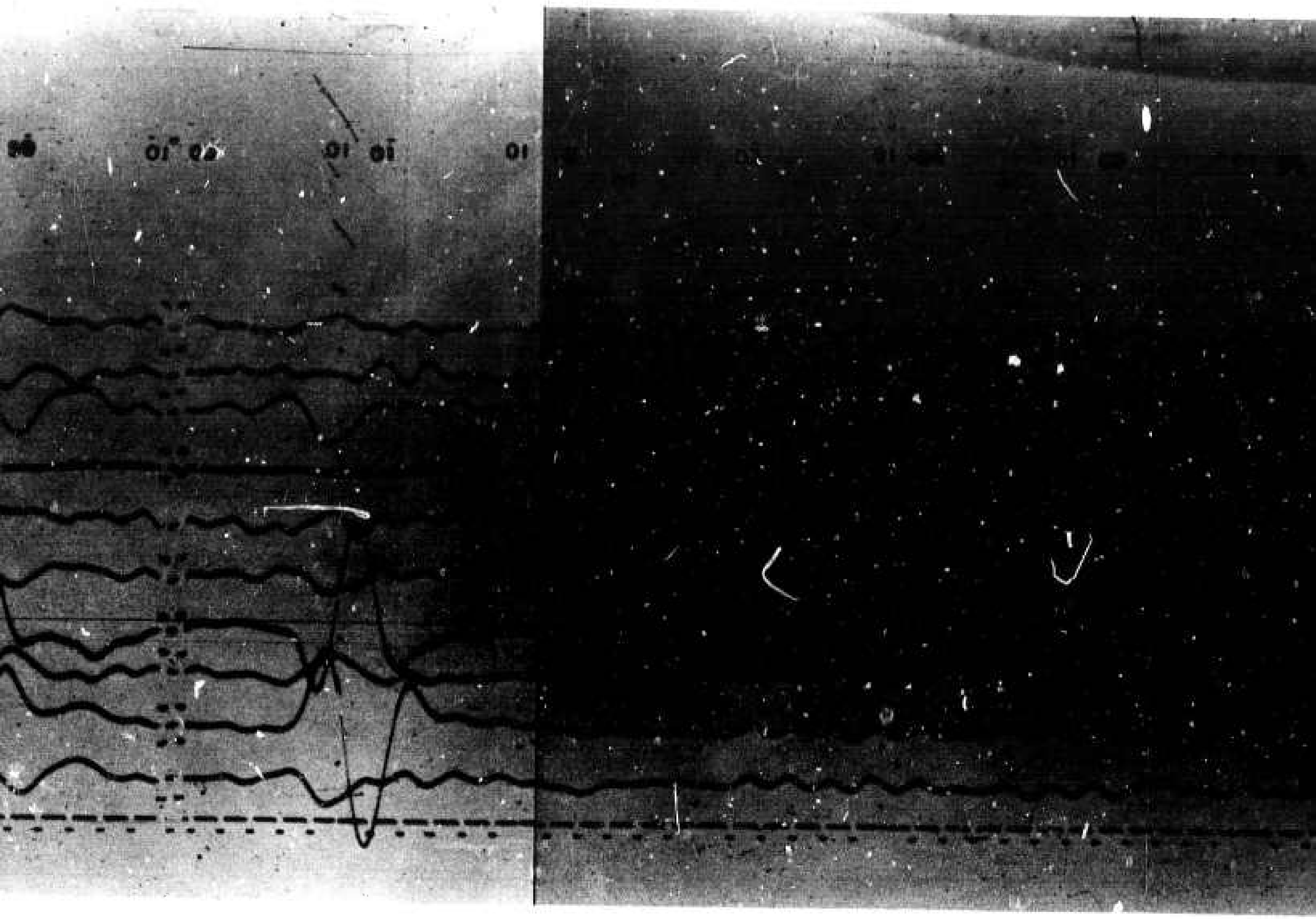

Figure 5. Seismogram illustrating
triaxial (T_1LP, T_2LP, T
mograph systems (ZLP_2,
artificially induced su
16 millimeter film)

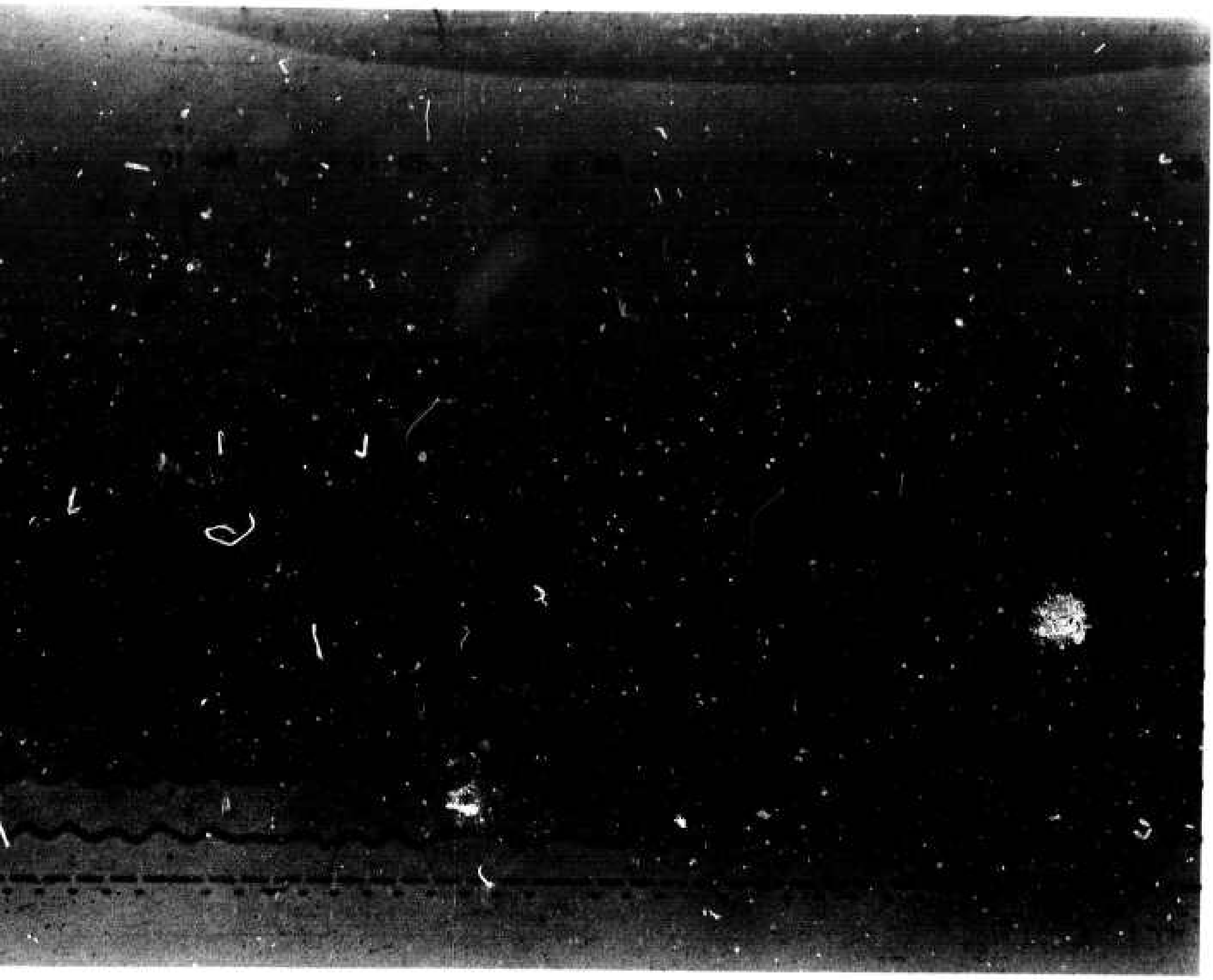

Figure 5. Seismogram illustrating the relative responses of the long-period triaxial (T_1LP, T_2LP, T_3LP) and the advanced long-period seismograph systems (ZLP_2, NLP_2, ELP_2), as operated at UBSO, to artificially induced surface tilt (X10 enlargement of 16 millimeter film)

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b. Mass locking mechanism;

c. Tilt tables and tilt table drive;

d. Auxiliary mass mechanism;

e. Motor type;

f. Control circuitry.

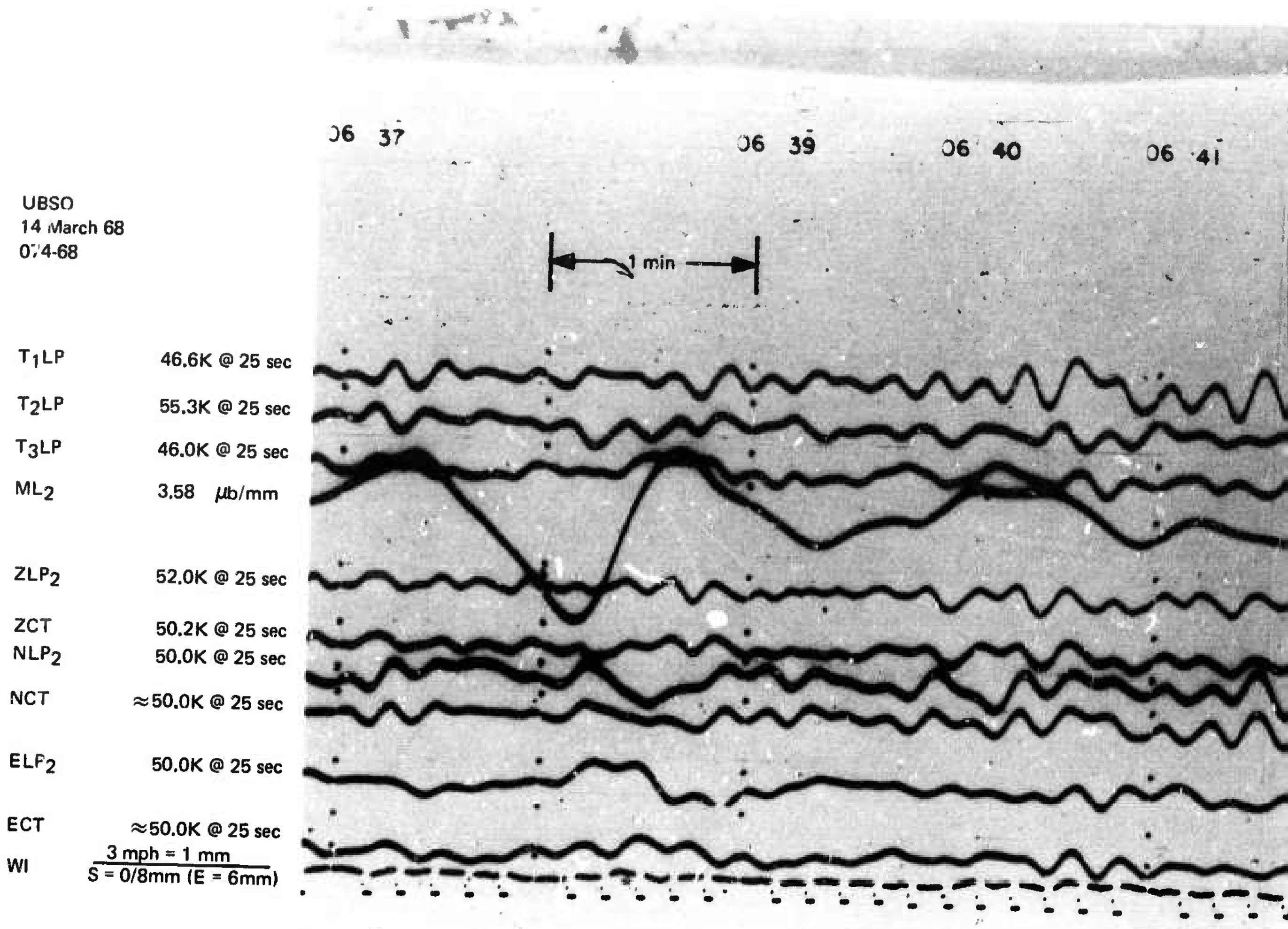
The period adjust mechanism has been redesigned to provide a linear period change versus motor "run time." This design is contrasted with the former design in which only a short motor run was required to change the seismometer free period 1 second at the longer periods, and a long motor run was required at the shorter periods. This made the amount of any period change difficult to predict since the period change motor "run time" relationship was only generally known. The new design mechanism should make it possible to adjust to the required free period from a particular value in a minimum of time and to a much higher precision than before. A model of the redesigned period adjust mechanism has been completed and is in the process of being tested.

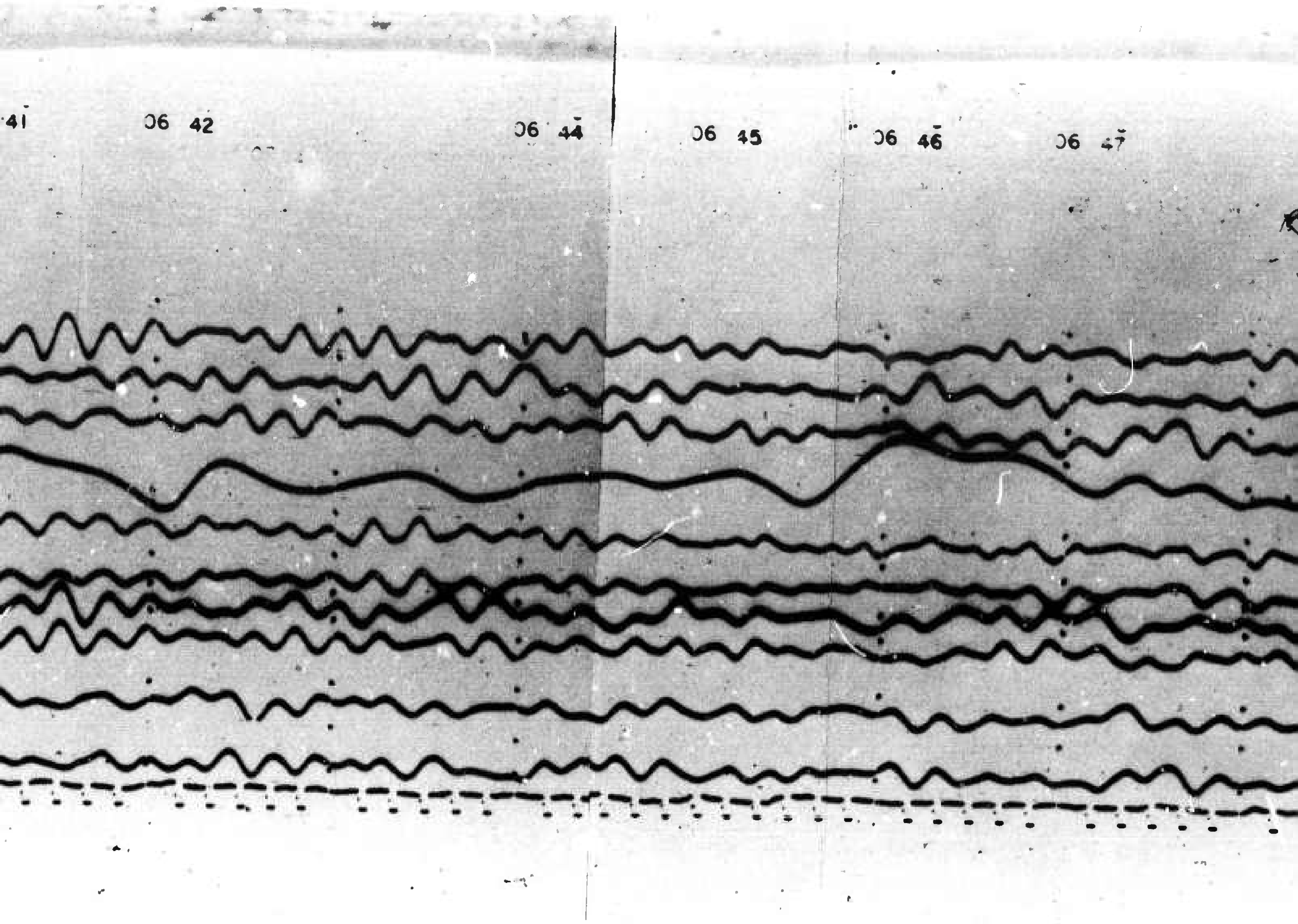
There has been a substantial simplification of the mass locking mechanism made possible through redesign. This will reduce the cost of the mechanism compared to the former more complex design. All of the important features of the initial design, which contributed to the protection of the seismometer suspension during shipment and installation, have been retained. Thus, it is expected that the redesigned module will be as transportable as the experimental units now operating at UBSO.

Additional redesign effort has been directed toward elimination of the relatively complex and expensive auxiliary mass mechanism (used to control mass position). Mass position of the improved module is to be controlled by a more sensitive leveling method in which leveling in the sensitive axis is controlled by a proportional servo, rather than the contactor servo formerly used. Thus, the number of motors required to control the seismometer module has been reduced to those which level the seismometer and adjust the free period.

A considerable amount of effort has been made to select a motor to drive the various mechanisms which permit remote adjustment of the seismometer modules. A small inexpensive stepping motor has been found which promises to solve the motor selection problem. This motor has been subjected to environmental tests while operating at its maximum rated torque and so far appears to satisfy the requirements. Since this motor is, in effect, a brushless dc motor, it retains the high torque characteristics of a dc motor while also exhibiting the reliability of the ac motors formerly used.

The stepping motor selected lends itself to digital control since it responds to dc pulses. In the case of the period adjust motor, these pulses are generated uphole, while the leveling motors (which include the mass position motor) are controlled from pulses generated downhole. The period adjust stepping motor, combined with the linearized period adjust mechanism, will allow a precision adjustment of the free period since a discrete number of pulses can be used to adjust the free period a predictable amount.


UBSO
14 March 68
074-68
06 37
06 39
06 40
06 41
1 min
T1LP 46.6K @ 25 sec
T2LP 55.3K @ 25 sec
T3LP 46.0K @ 25 sec
ML2 3.58 μb/mm
ZLP2 52.0K @ 25 sec
ZCT 50.2K @ 25 sec
NLP2 50.0K @ 25 sec
NCT ≈50.0K @ 25 sec
ELP2 50.0K @ 25 sec
ECT ≈50.0K @ 25 sec
WI 3 mph = 1 mm
S = 0/8mm (E = 6mm)



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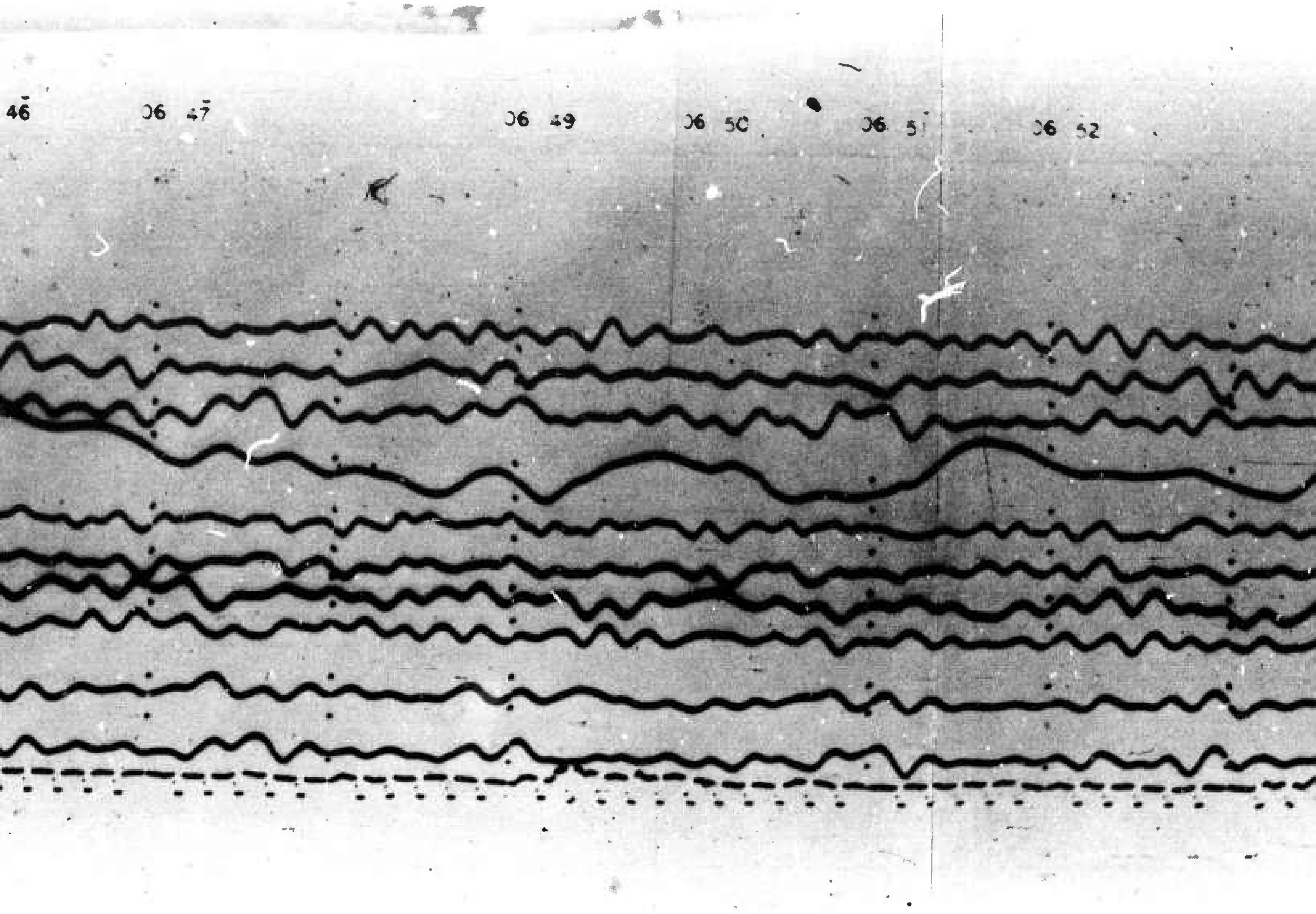

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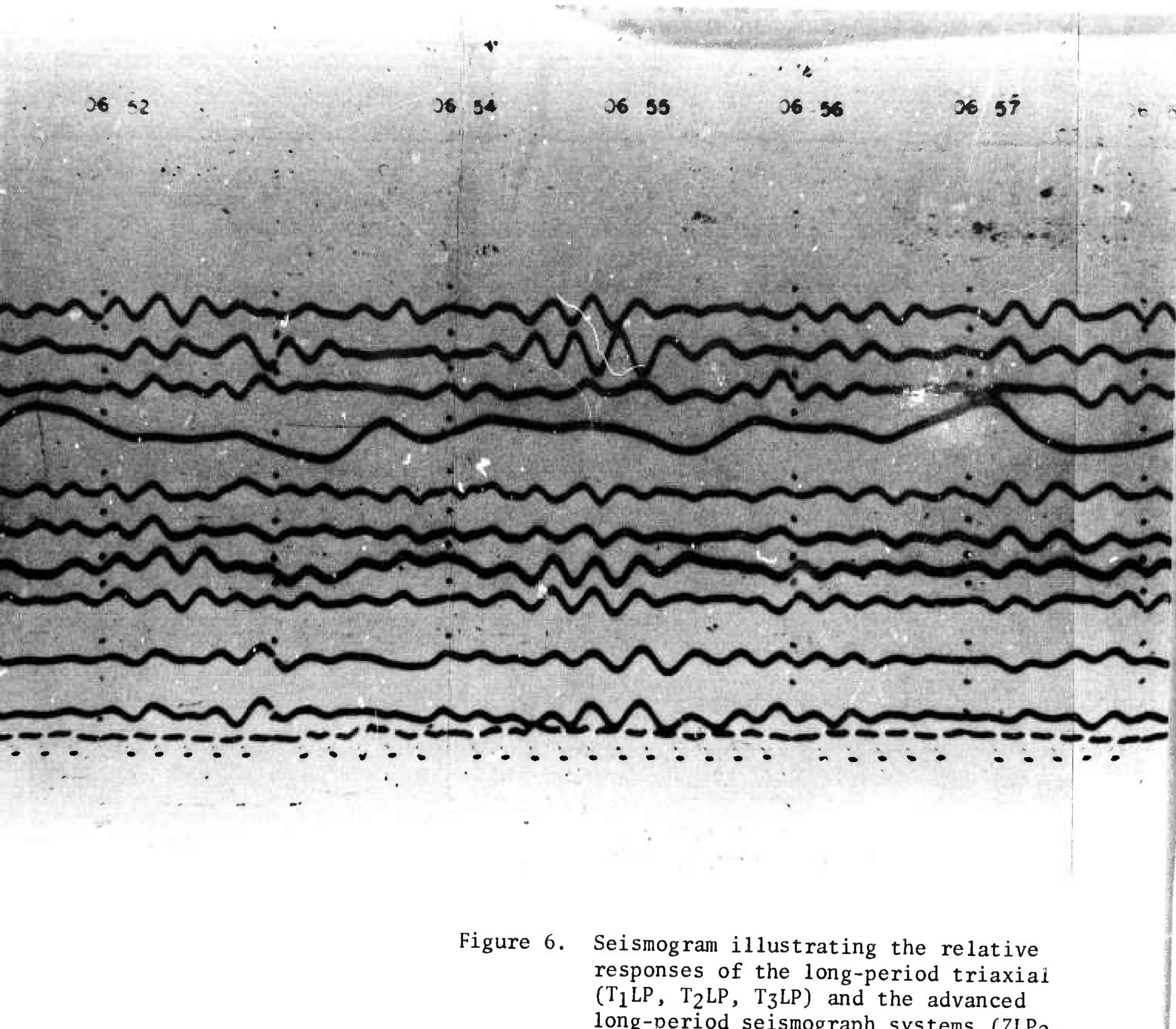
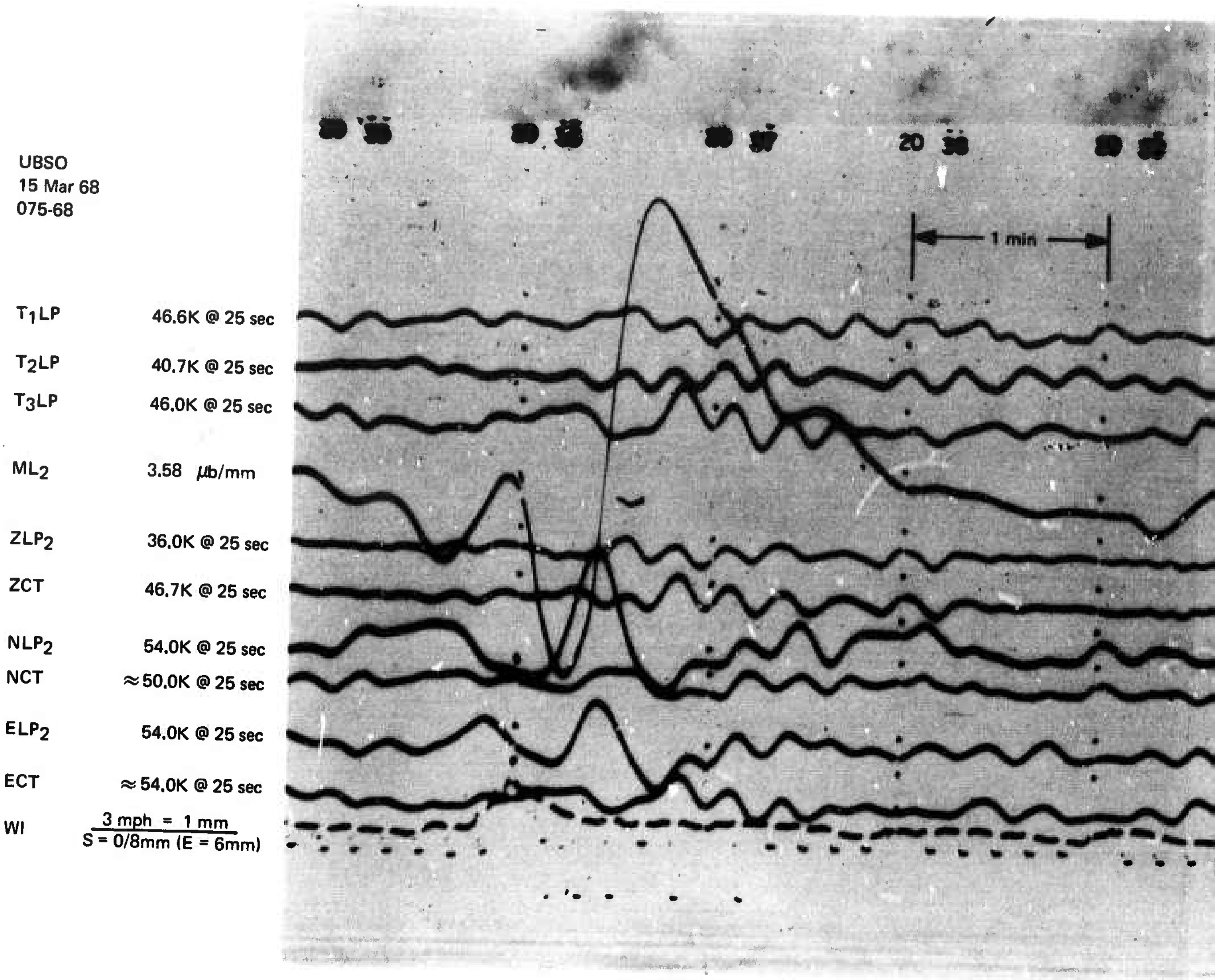


Figure 6. Seismogram illustrating the relative responses of the long-period triaxial (T_1LP, T_2LP, T_3LP) and the advanced long-period seismograph systems (ZLP_2, NLP_2, ELP_2) as operated at UBSO, to barometric pressure change (trace ML_2) accompanied by low wind (trace WI) (X10 enlargement of 16 millimeter film)

D


UBSO
15 Mar 68
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20
1 min
T1LP 46.6K @ 25 sec
T2LP 40.7K @ 25 sec
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ML2 3.58 µb/mm
ZLP2 36.0K @ 25 sec
ZCT 46.7K @ 25 sec
NLP2 54.0K @ 25 sec
NCT ≈50.0K @ 25 sec
ELP2 54.0K @ 25 sec
ECT ≈54.0K @ 25 sec
WI 3 mph = 1 mm
S = 0/8mm (E = 6mm)

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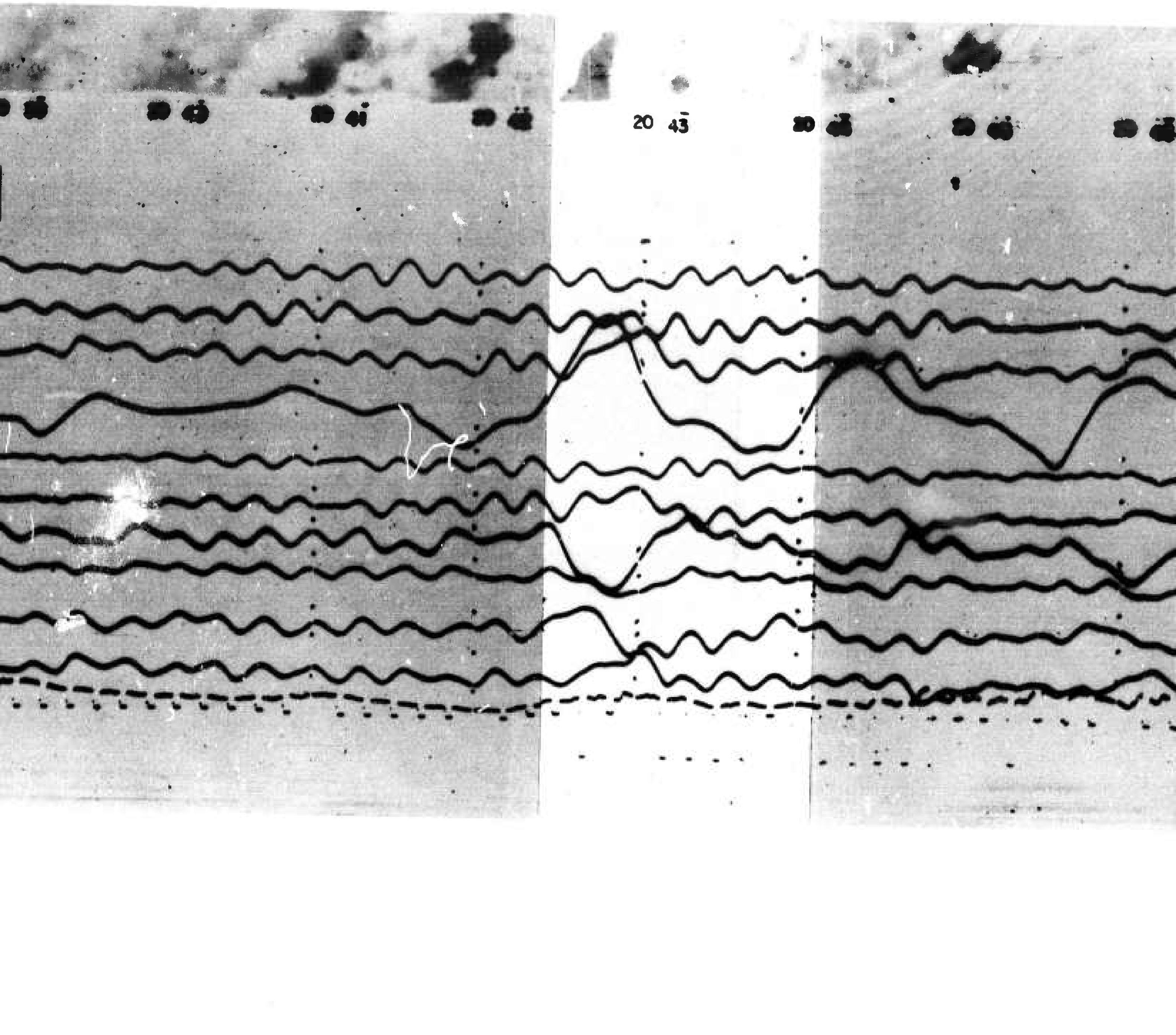

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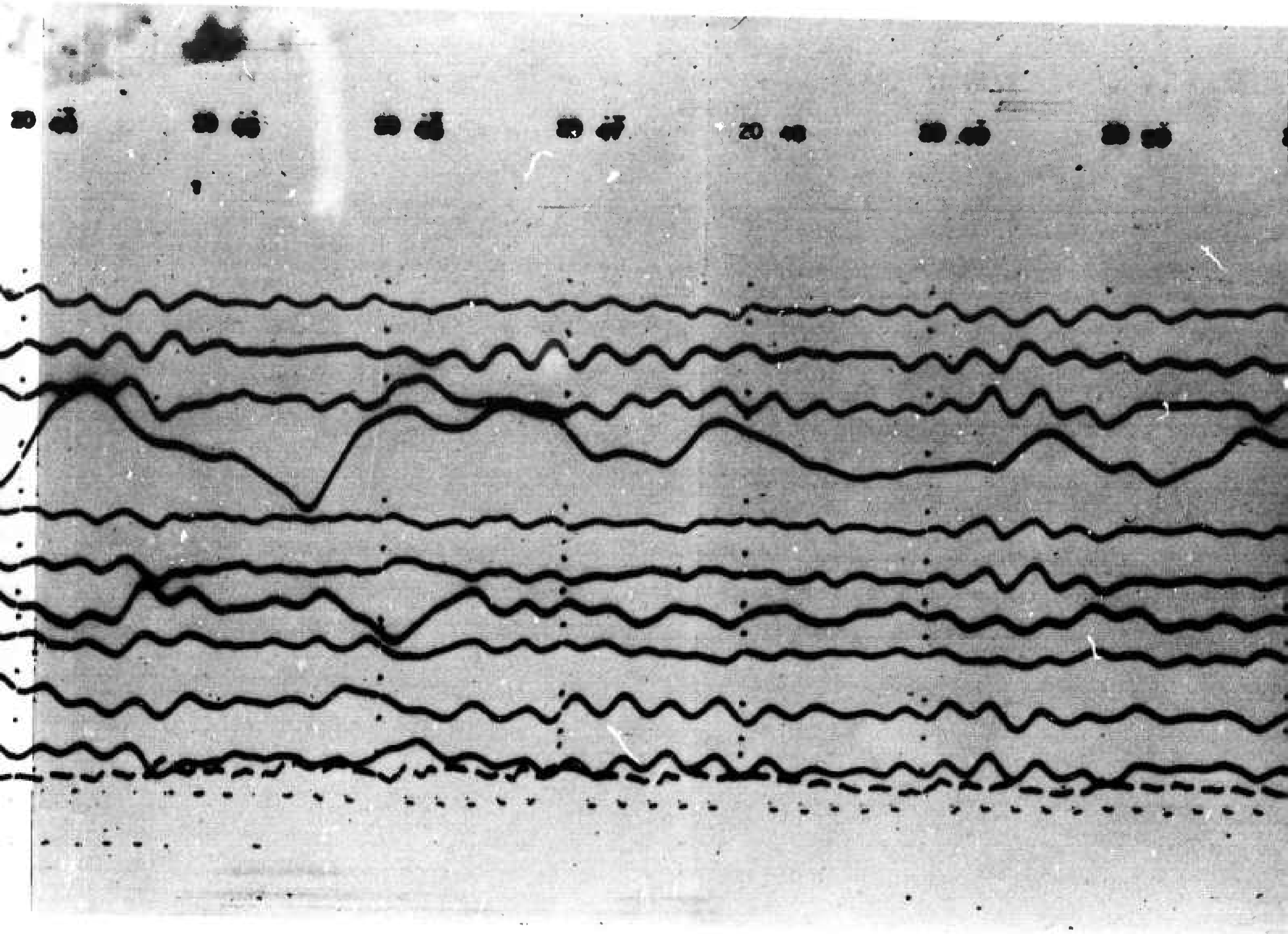

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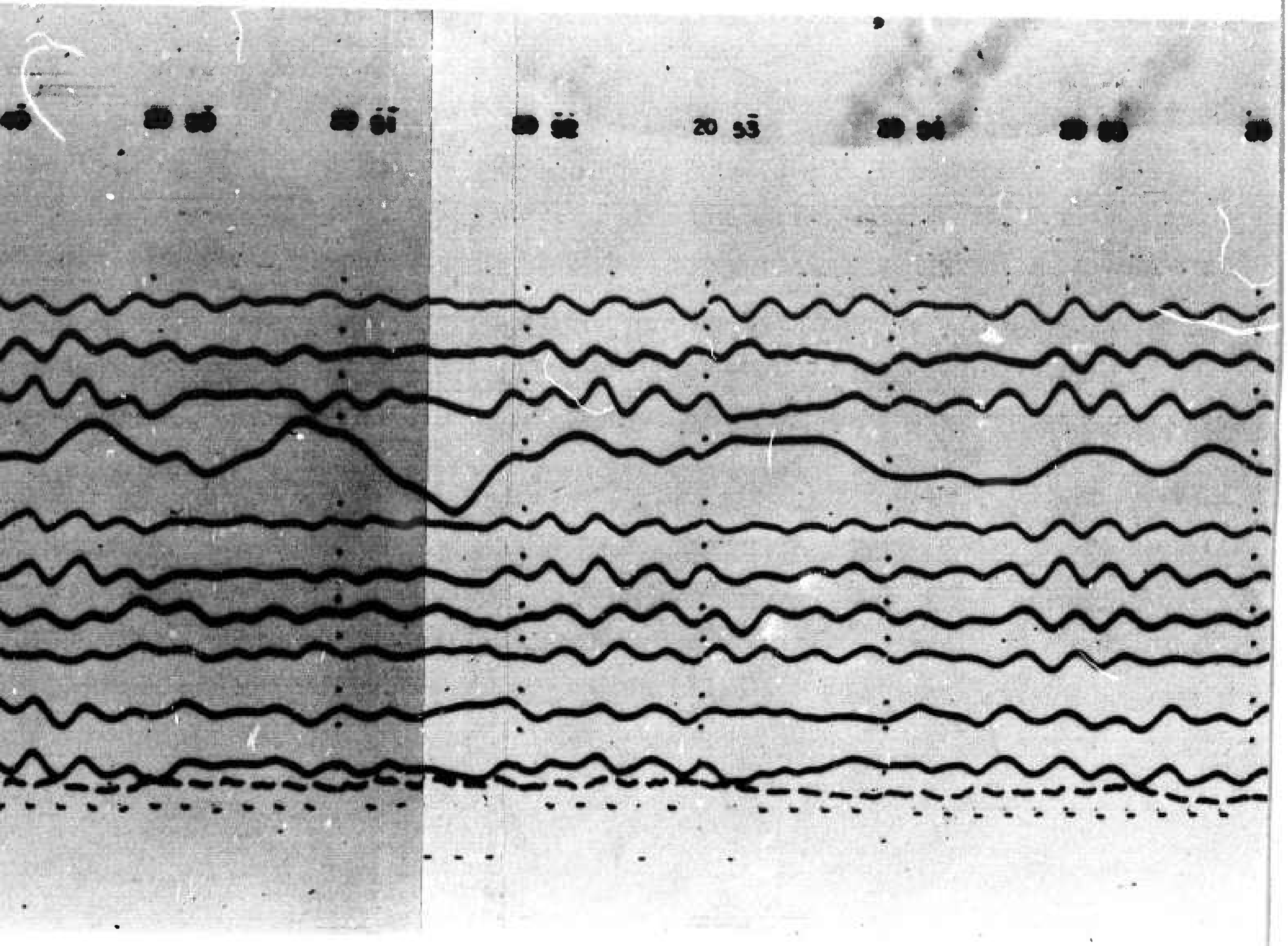


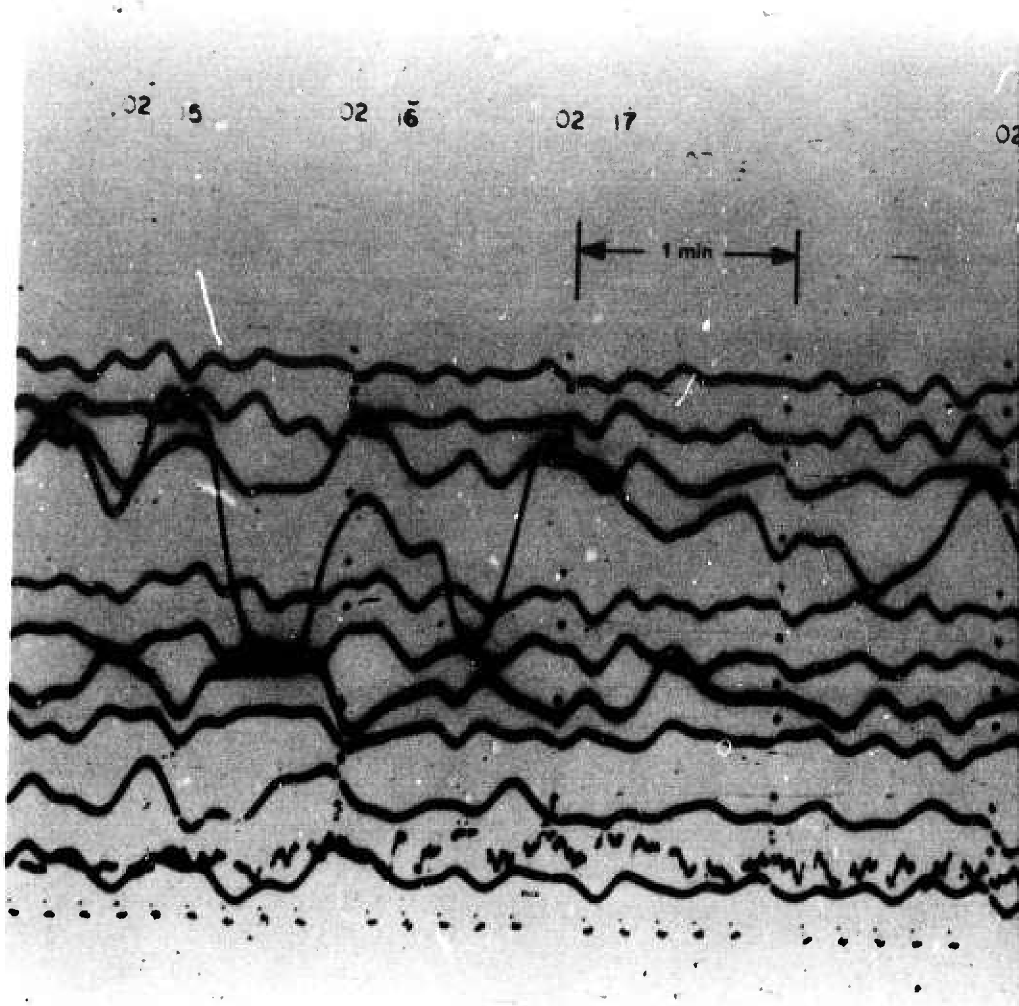
Figure 7. Seismogram illustrating the relative responses of the long-period triaxial (T_1LP, T_2LP, T_3LP) and the advanced long-period seismograph systems (ZLP_2, NLP_2, ELP_2), as operated at UBSO, to a large barometric pressure change (trace ML_2) accompanied by gusting winds (trace WI) (X10 enlargement of 16 millimeter film)

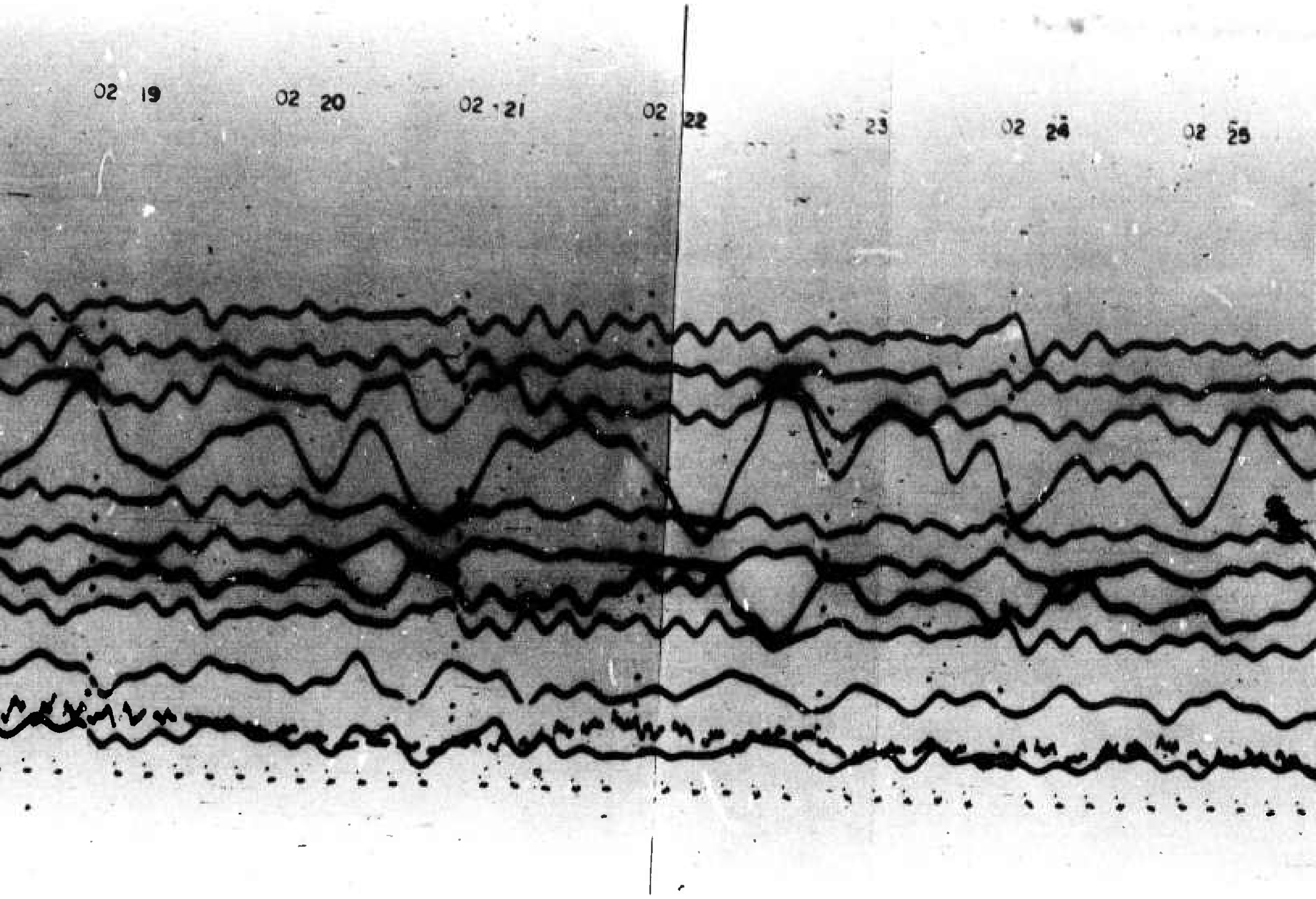
G 4119

UBSO
14 March 68
074-68

T$_1$LP 46.6K @ 25 sec
T$_2$LP 55.3K @ 25 sec
T$_3$LP 46.0K @ 25 sec
ML$_2$ 3.58 μb/mm

ZLP$_2$ 52.0K @ 25 sec
ZCT 50.2K @ 25 sec
NLP$_2$ 50.0K @ 25 sec
NCT ≈ 50.0K @ 25 sec
ELP$_2$ 50.0K @ 25 sec
ECT ≈ 50.0K @ 25 sec
WI $\frac{3 \text{ mph} = 1 \text{ mm}}{S = 0/8\text{mm } (E = 6\text{mm})}$





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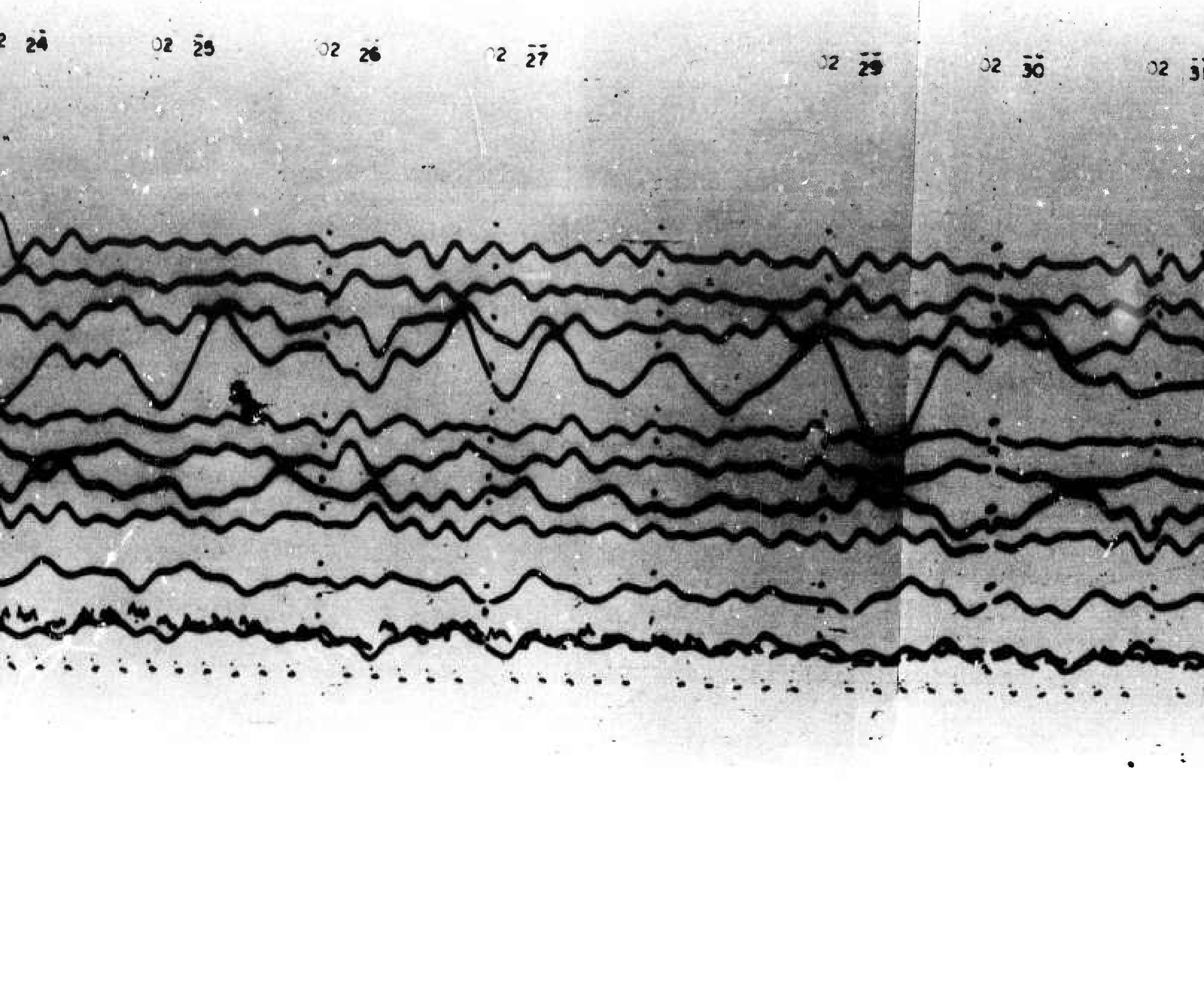

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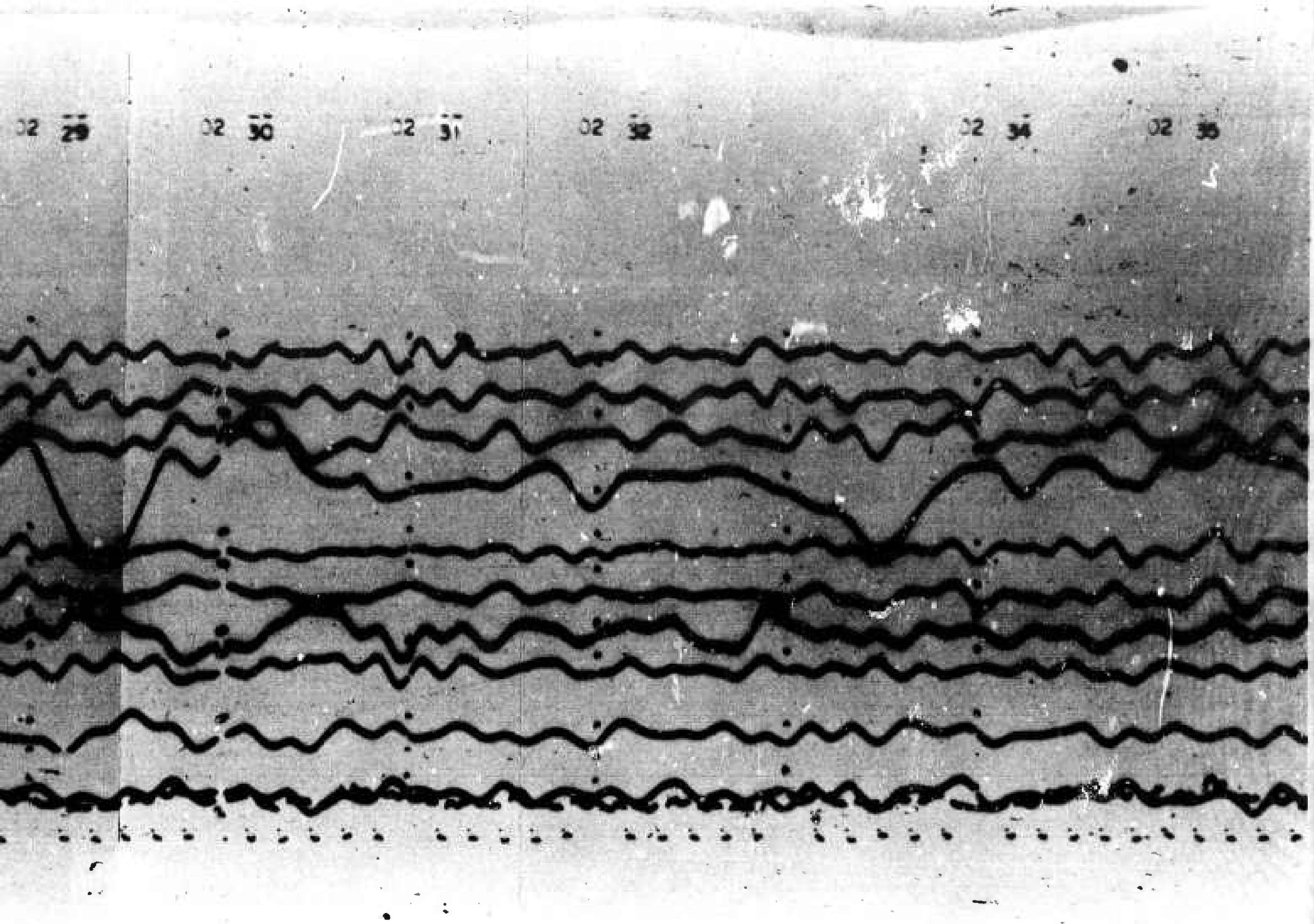

Figure 8. Seismogram illustrating the relative responses of the long-period triaxial (T_1LP, T_2LP, T_3LP) and the advanced long-period seismograph systems (ZLP_2, NLP_2, ELP_2), as operated at UBSO, to barometric pressure changes (trace ML_2) accompanied by winds gusting above 30 mph (trace WI) (X10 enlargement of 16 millimeter film)

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The stepping motor, as used to level the seismometer in the sensitive axis, will be controlled by a variable pulse-rate oscillator. The rate of the oscillator is controlled by the mass position monitor, and is proportional to the error in the mass position, approaching zero as the mass approaches zero. Activation of the leveling circuit results in the tilt tables automatically leveling the seismometer suspension so that the final position of the mass approaches zero. Any correction required in the mass position is accomplished by reactivating the leveling circuits.

The control circuitry using the new motor has been designed and the variable rate oscillator required to control the leveling motor has been breadboarded and tested. The control circuitry has been significantly simplified compared to the former one, as has been the uphole control unit. This has resulted in a reduction in the number of conductors required between modules, as well as those running to the surface.

The practical result of the redesign, as it is now seen, is expected to show improved reliability and cost reduction. This is thought to have been accomplished while maintaining the quality of performance of the triaxial system now being operated at UBSO.

APPENDIX to TECHNICAL REPORT NO. 68-20

STATEMENT OF WORK TO BE DONE

EXHIBIT "A"

STATEMENT OF WORK TO BE DONE

AFTAC Project Authorization No. VELA T/6706

1 - MAR 1966

1. Tasks:

a. Experimental Investigation of Thermal Noise. Continue the experimental investigation, defined in Project VT/072, of thermal noise components in seismograph systems, using torsional pendulums and associated equipment available from that project. Determine experimentally the spectral distributions of thermal noise in seismograph systems and compare the experimental results with theoretical predictions, as those derived by the National Bureau of Standards, for example. Provide data and methods for determining the ultimate possible magnification of a seismograph. Work on this task is to be completed within 4 months of the initial authorization date.

b. Development of a Long-Period Triaxial Borehole Seismometer. Modify the "Melton" long-period triaxial seismometer developed under Project VT/072 to adapt it for routine operation in shallow (200-foot) boreholes. Reduce the seismometer's diameter so it will fit inside standard 13.375-inch outside diameter shallow-well casing. Develop and add a suitable level sensor and remotely-controlled levelling device.

c. Preliminary Testing of the Long-Period Triaxial Borehole Seismometer. Prepare a cased, shallow borehole at a VELA seismological observatory to be designated by the AFTAC project officer. Assemble handling equipment for installing the seismometer. Conduct preliminary tests of the modified instrument in the test hole to determine its stability and the effects of temperature and local tilting as functions of depth. Through the use of improved installation techniques, selective filtering, design improvement or other means, develop a method for operating the seismometer so that magnification in the 10 to 100 sec period band is limited only by propagating seismic noise.

d. Field Measurements with the Long-Period Triaxial Borehole Seismometer. Collect and analyze data to determine long-period signal and noise characteristics in shallow boreholes, to identify principal long-period seismic noise components, to ascertain depth-environmental effects, and to compare the performance of the triaxial borehole seismometer with standard long-period seismometers.

2. Data Requirements: Provide report as specified by DD Form 1423, with Attachment 1 thereto.

AF 33(657)-16406

Attachment 1 to DD Form 1423

REPORTS

AFTAC Project Authorization No. VELA T/6706

1. General: Provide monthly, quarterly, final, and special reports in accordance with sentence 1, paragraph 1 of Data Item S-17-12.0, AFSCM 310-1; however, if that data item conflicts with the instructions of paragraph 2 below, the latter will take precedence.

2. Reports:

a. Monthly Status Reports. A monthly letter-type status report in 16 copies, summarizing work for the calendar month, will be submitted to AFTAC by the 5th day of the following month. Each report will be identified by the data listed in paragraph 2e and will include, but not be limited to, the following subject areas:

(1) Technical Status. Include accomplishments, problems encountered, future plans, actions required by the government, and appropriate illustrations and photographs.

(2) Financial Status. The contractor will follow the provisions of Data Item A-15-17.0, AFSCM 310-1A (Cost Planning and Appraisal Unit), in submitting financial data.

For the last month of each report period covered by a quarterly progress report, the monthly status report need include only the financial information.

b. Quarterly Progress Reports. Quarterly progress reports in 50 copies, summarizing work for 3-month periods, will be submitted to AFTAC within 15 days after the close of each such period. Each report will be identified by the data listed in paragraph 2e and will include the notices listed in paragraph 2f. Each report will present a precise and factual discussion of the technical findings and accomplishments for the entire report period, using a format similar to that of the final reports under Contract AF 33(657)-9967, as well as the technical information ordinarily required in the monthly reports.

c. Final Reports. The final report on Task 1a will be submitted in 50 copies to AFTAC within 60 days after work on that project is completed; the final report on the remaining tasks will be submitted in 50 copies within 60 days after the completion of all work. Each report will be identified by the data listed in paragraph 2e and will include the notices listed in paragraph 2f. Each report will present a complete and factual discussion of the technical findings and accomplishments of the project tasks, using the quarterly-report format.

d. Special Reports.

(1) Special reports of major events will be forwarded by telephone, telegraph, or separate letter as they occur and should be included in the

following monthly report. Specific items are to include, but are not restricted to program delays, program breakthroughs, and changes in funding requirements.

(2) Special technical reports may be required for instrument evaluations, project recommendations, and special studies when it is more desirable to have these items reported separately from the quarterly or final reports. Specific format, content, number of copies, and due dates will be furnished by this headquarters.

(3) All seismograms and operating logs, including pertinent information concerning time, date, type of instruments, magnification, etc., will be provided when requested by the AFTAC project officer.

e. Identification Data. All monthly, quarterly, and final reports will be identified by the following data:

AFTAC Project No. VELA T/6706.

Project Title.

ARPA Order No. 624.

ARPA Program Code No. 6F10.

Name of Contractor.

Contract Number.

Effective Date of Contract.

Amount of Contract.

Name and phone number of Project Manager, Scientist, or Engineer.

f. Notices.

(1) All quarterly and final reports will include the following notices on the cover and first page or title page:

Sponsored by
Advanced Research Projects Agency
Nuclear Test Detection Office
ARPA Order No. 624

Qualified users may request copies of this document from:

Defense Documentation Center
Cameron Station
Alexandria, Virginia 22341

This research was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, under the VELA-UNIFORM Program and was accomplished under the technical direction of the Air Force Technical Applications Center under contract AF 33(657)-16406 .

(2) All quarterly and final reports will include a copy of DD Form 1473, Document Control Data - R&D (Reference AFR 80-29). AFTAC will designate the appropriate Availability/Limitations Notice for use on these forms.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

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3. REPORT TITLE
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LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
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5. AUTHOR(S) (First name, middle initial, last name)
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY HQ USAF (AFTAC/VELA Seismological Center) Washington, D. C. 20333

13. ABSTRACT

Field testing of tne long-period triaxial seismometer has continued at the Uinta Basin Seismological Observatory (UBSO). The results of tests involving artificially induced tilt and the response of the system to wind and barometric pressure change are presented. ( )

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Long-period borehole seismometer VT/6706						